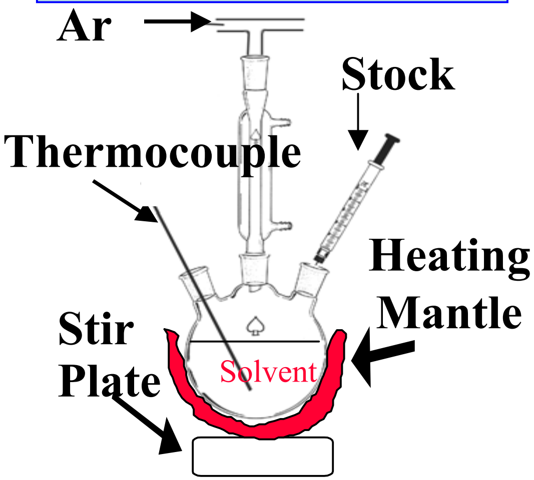
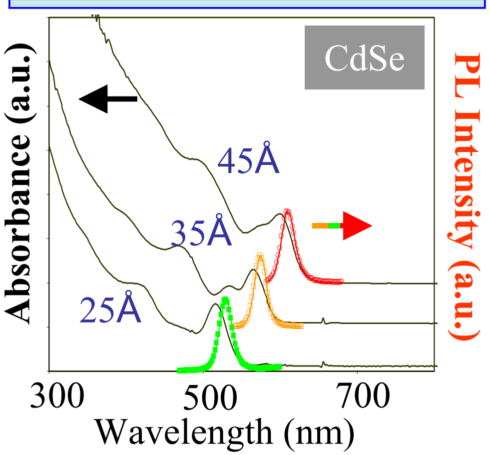
Colloidal Nanocrystals

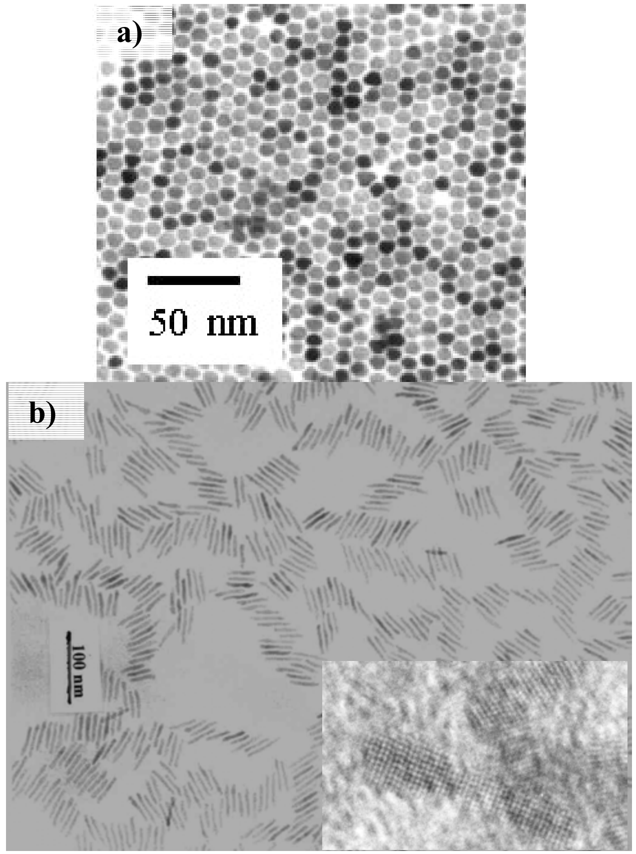
1. Colloidal Growth



2. Size Dependent Photoluminescence

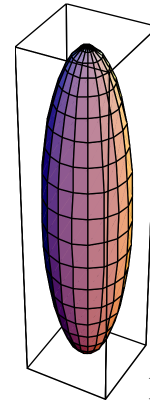


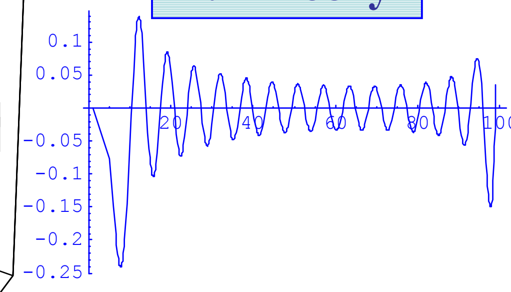
3. Electron Microscopy



Transmission Electron micrographs of dots (a) and rods (b). Inset shows *lattice* image of rods.

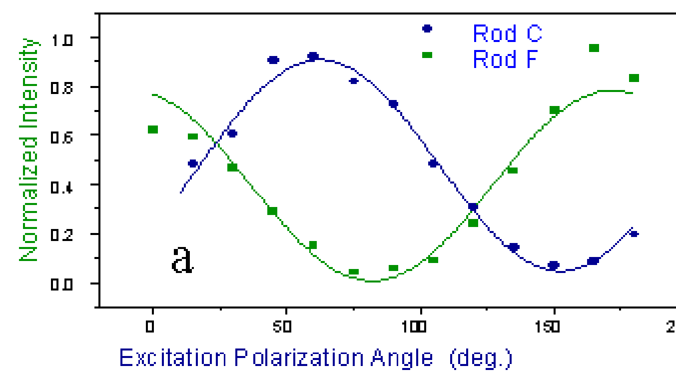
4. Theory





Rods are modeled as "prolate spheroids" (left), so that we can analytically solve for their excitation energies (as the zeroes in graph).

5. Orientation Dependent PhotoLuminescence



Colloidal CdSe nanocrystals are grown using chemical means **(1)** . Their luminescence/absorption are strongly dependent on their size **(2)** . Electron Microscopy demonstrates close-packing of dots **(3a)** and some ordering of rods **(3b)** . The rods can be analytically modeled as prolate spheroids allowing simple comparison of experiment with theory **(4)** . Anisotropy of rods is reflected in orientational dependence in luminescent polarization **(5)** .

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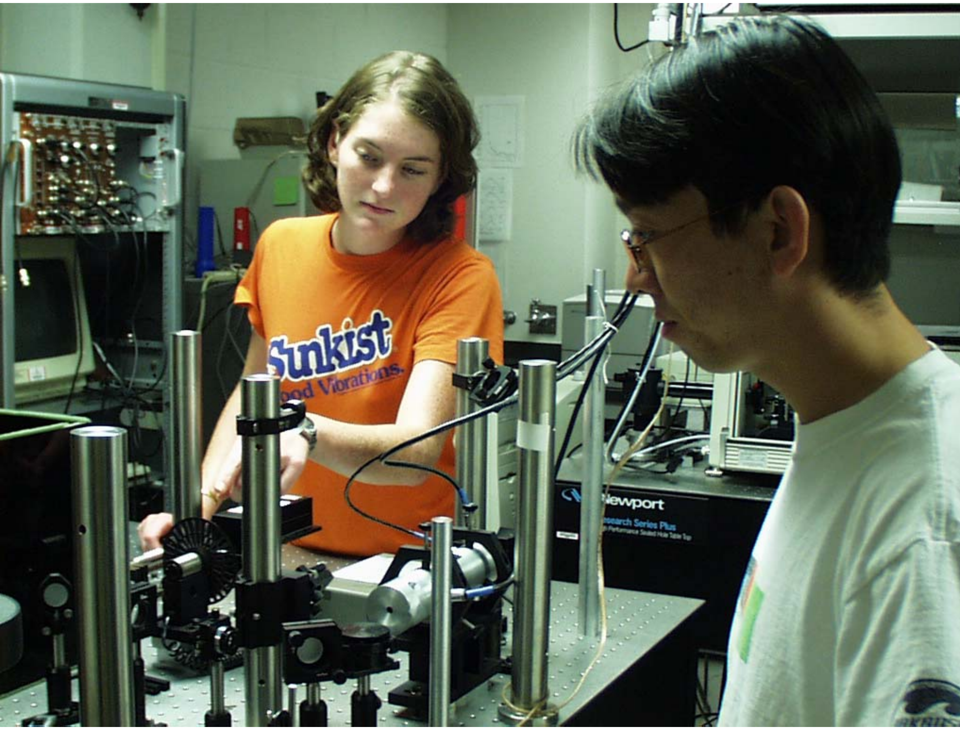
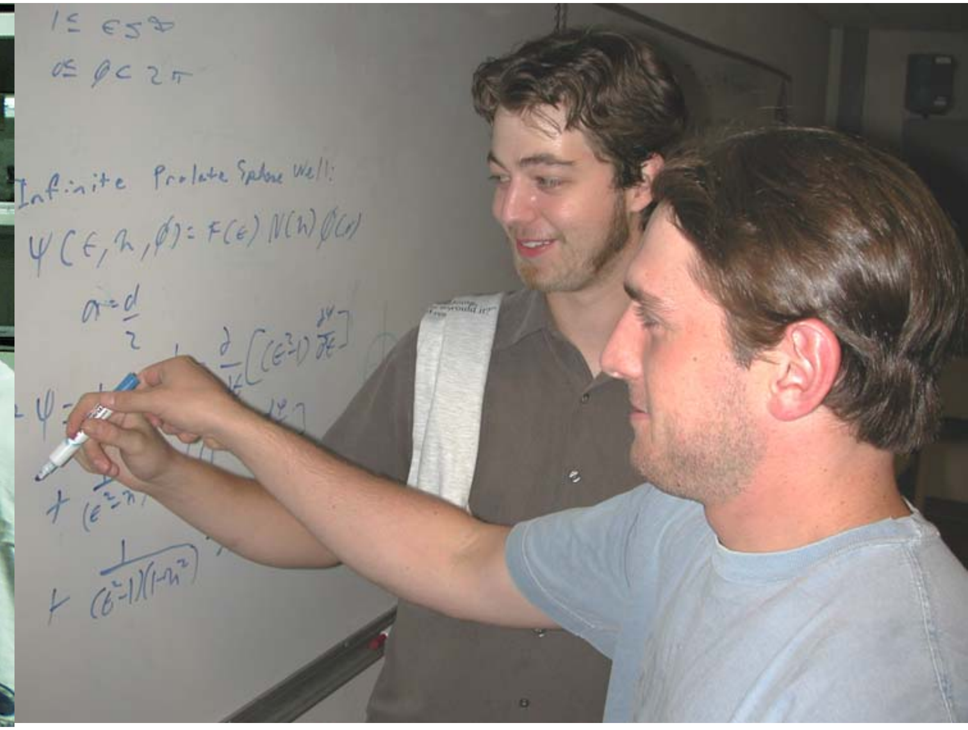




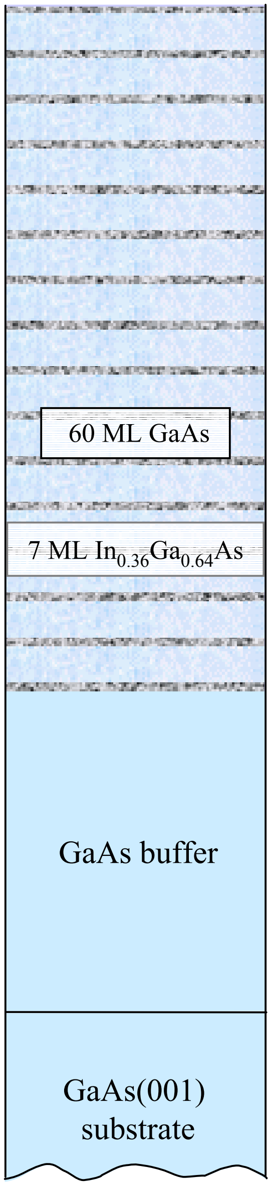
Arkansas Physics REU student, Molly Darragh, working with graduate student, Kiaoyuan Wang, on the optics apparatus used to investigate the Photoluminescence of the rods and dots.

Oklahoma Physics REU students, Jeremy Marzuola and Chad Fendt discussing the calculations involved in coordinate transformations to study the energies of quantum rods.

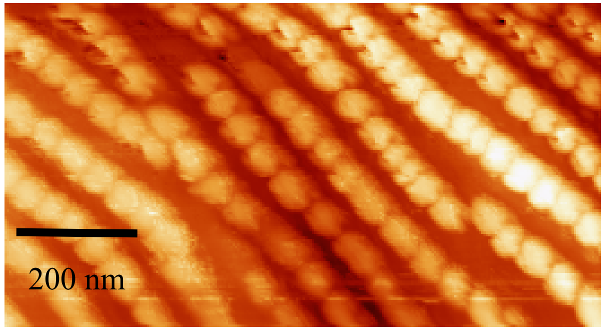
The simplicity of the nanocrystal geometry makes it a perfect opportunity for undergraduates to apply their knowledge of quantum mechanics to nanostructured materials both experimentally (left) and theoretically (right).

MBE-Grown Nano Wires and Dots

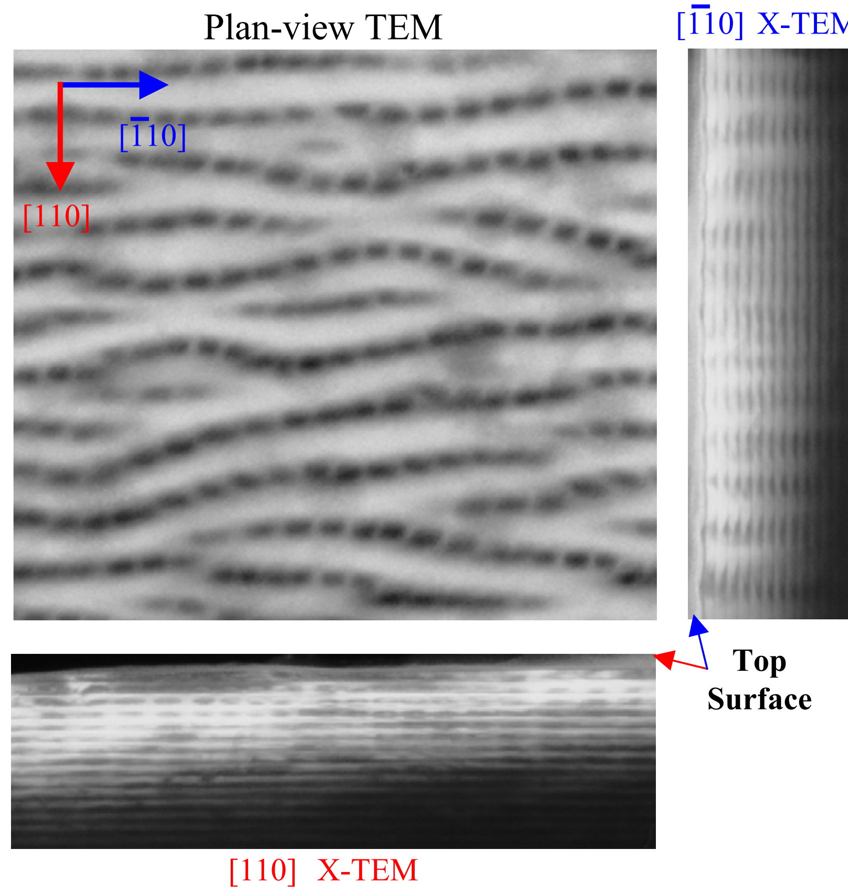
1. MBE Growth Plan



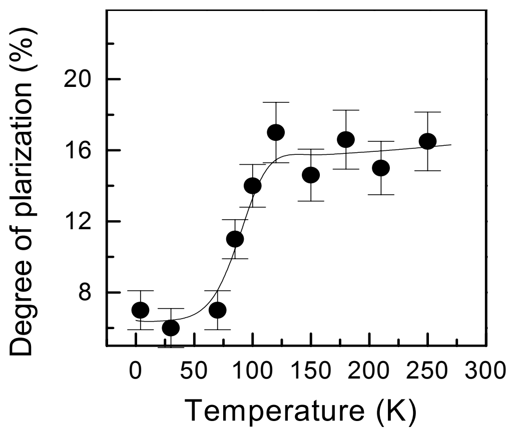
2. STM Plan-view



3. TEM Composite Views



4. Polarization of Photoluminescence



Usually Molecular Beam Epitaxy (MBE) is used to grow ultra-flat layers. However, in the case of the superlattice consisting of 16 repeats of 60 monolayers (ML) GaAs followed by 7 ML $In_{0.36}Ga_{0.64}As$ **(1)** , the $In_{0.36}Ga_{0.64}As$ layer spontaneously forms chains of dots, as seen in the top layer directly imaged by scanning tunneling microscopy **(2)** . What is not clear is whether the dots in the 16 sublayers are aligned in any way. Transmission electron microscopy (TEM), not as surface sensitive as STM, clearly shows both stacking of the chains and even stacking of the dots themselves **(3)** ! The stacking and anisotropy of these chains leads to polarization dependent photoluminescence **(4)** .

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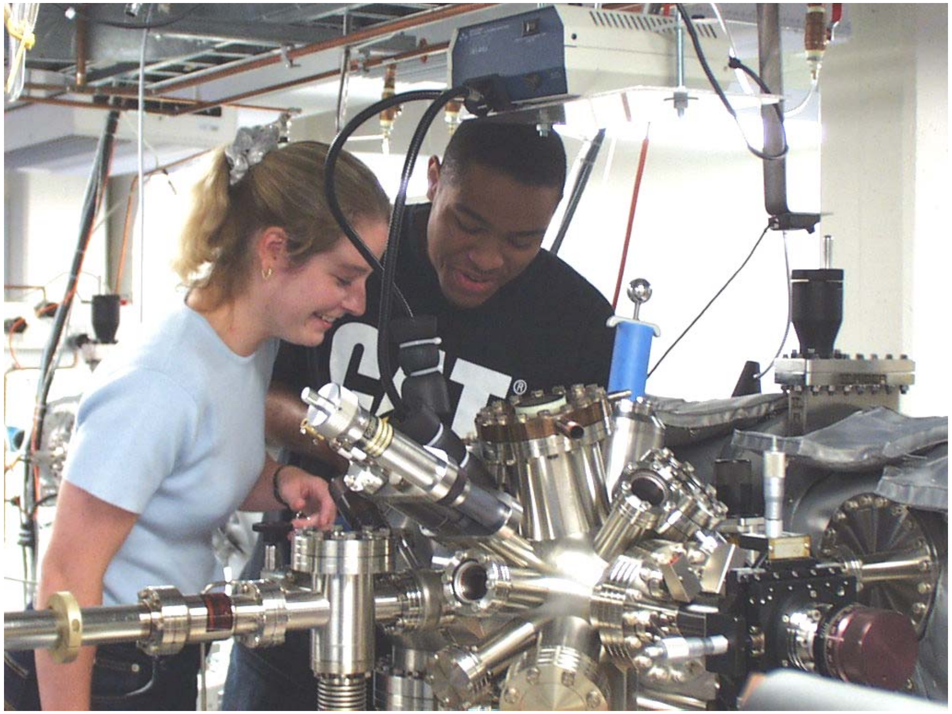
MBE-Grown Nano Wires and Dots



REU students, Erica Elvey and Byron Williams, at Arkansas involved with sample transport on Arkansas's multi-chamber Molecular Beam Epitaxy (MBE) System.

Spreading the word: undergraduates and school teachers are involved in the research in epitaxial growth at CSPIN. Exposing them to materials research helps them understand the basis of modern nanoelectronics.

Oklahoma high school teachers, Jason Rausch and David Askey, meet with researcher Tetsuya Mishima, who uses a crystal model to explain the affect of sample orientation on the Transmission Electron Microscope (TEM) image.